CLAIMS

We claim:

1. A method of polishing a metal layer, comprising the steps of:

providing a structure having an upper patterned dielectric layer; the patterned dielectric layer having an opening formed therein;

forming a barrier layer over the patterned upper dielectric layer, the barrier layer lining the opening;

forming a metal layer over the barrier layer, filling the opening;

conducting a first polish step employing a first slurry composition, the first polish step removing a portion of the overlying metal layer;

conducting a second polish step employing the first slurry composition, the second polish step polishing the partially removed overlying metal layer and exposing portions of the barrier layer overlying the patterned upper dielectric layer;

conducting a third polish step employing a second slurry composition, the third polish step removing the exposed barrier layer portions and exposing underlying portions of the patterned upper dielectric layer; and

conducting a fourth polish step employing the second slurry composition and BTA, the fourth polish step buffing the exposed upper dielectric layer portions.

2. The method of claim 1, wherein the first polish step is conducted on a first platen; the second and third polish steps are conducted on a second platen; and the fourth polish step is conducted on a third platen.

3. The method of claim 1, wherein the first slurry composition is 600y-73 slurry manufactured by Cabot Microelectronics comprised of:

Al_2O_3: from about 0.4 to 0.6 wt. %;

H_2O_2: from about 2.6 to 3.4 wt. %;

KOH to adjust pH value; and

BTA as a corrosion behavior inhibitor.

4. The method of claim 1, wherein the first slurry composition is 600y-73 slurry manufactured by Cabot Microelectronics comprised of:

Al_2O_3: about 0.5 wt. %;

H_2O_2: from about 2.8 to 3.2 wt. %;

KOH to adjust pH value; and

BTA as a corrosion behavior inhibitor.

5. The method of claim 1, wherein the first slurry composition is 600y-73 slurry manufactured by Cabot Microelectronics having:

a) a pH of from about 2.8 to 4.3; and

b) a particulate size of from about 115 to 155 nm, weight basis.

6. The method of claim 1, wherein the first slurry composition is 600y-73 slurry manufactured by Cabot Microelectronics having:

a) a pH of about 4.1; and

b) a particulate size of from about 120 to 150 nm, weight basis.

7. The method of claim 1, wherein the second slurry composition is SS6 slurry manufactured by Cabot Microelectronics comprised of:

SiO_2: from about 5.8 to 6.2 wt. %; and

KOH to adjust pH value.

8. The method of claim 1, wherein the second slurry composition is SS6 slurry manufactured by Cabot Microelectronics comprised of:

SiO_2: about 6.0 wt. %; and

KOH to adjust pH value.

9. The method of claim 1, wherein the second slurry composition is SS6 slurry manufactured by Cabot Microelectronics having:

a) a pH of from about 9.8 to 11.4; and

b) a particulate size of from about 125 to 185 nm, weight basis.

10. The method of claim 1, wherein the second slurry composition is SS6 slurry manufactured by Cabot Microelectronics having:

a) a pH of from about 10.0 to 11.2; and

b) a particulate size of from about 130 to 180 nm, weight basis.

11. The method of claim 1, wherein the fourth polish step employs the second slurry composition that is SS6 slurry manufactured by Cabot Microelectronics comprised of:

SiO_2: from about 5.8 to 6.2 wt. %; and

KOH to adjust pH value;

and from about 0.10 to 0.14% BTA.

12. The method of claim 1, wherein the fourth polish step employs the second slurry composition that is SS6 slurry manufactured by Cabot Microelectronics comprised of:

SiO_2: about 6.0 wt. %; and

KOH to adjust pH value;

and about 0.12% BTA.

13. The method of claim 1, wherein the fourth polish step employs the second slurry composition that is SS6 slurry manufactured by Cabot Microelectronics having:

a) a pH of from about 9.8 to 11.4; and

b) a particulate size of from about 125 to 185 nm, weight basis;

and from about 0.10 to 0.14% BTA.

14. The method of claim 1, wherein the fourth polish step employs the second slurry composition that is SS6 slurry manufactured by Cabot Microelectronics having:

a) a pH of from about 10.0 to 11.2; and

b) a particulate size of from about 130 to 180 nm, weight basis;

and about 0.12% BTA.

15. The method of claim 1, wherein:

the first polish step is conducted at from about 2.0 to 2.4 psi for from about 36 to 44 seconds; and then at from about 1.0 to 1.4 psi for from about 18 to 22 seconds;

the second polish step is conducted at from about 1.0 to 1.4 psi for from about 41 to 49 seconds;

the third polish step is conducted at from about 1.8 to 2.2 psi for from about 31 to 39 seconds; and

the fourth polish step is conducted at from about 1.8 to 2.2 psi for from about 40 to 60 seconds.

16. The method of claim 1, wherein:

the first polish step is conducted at about 2.2 psi for about 40 seconds; and then at about 1.2 psi for about 20 seconds;

the second polish step is conducted at about 1.2 psi for about 45 seconds;

the third polish step is conducted at about 2.0 psi for about 35 seconds; and

the fourth polish step is conducted at about 2.0 psi for about 50 seconds.

17. The method of claim 1, wherein the structure is a semiconductor substrate.

18. The method of claim 1, wherein the upper patterned dielectric layer is comprised of silicon oxide, silicon nitride, FSG or silicon oxynitride; the barrier layer is comprised of TaN or Ta; and the metal layer is comprised of copper aluminum or gold.

19. The method of claim 1, wherein the upper patterned dielectric layer is comprised of silicon oxide; the barrier layer is comprised of TaN; and the metal layer is comprised of copper.

20. The method of claim 1, wherein the patterned dielectric layer is from about 10,000 to 12,000Å thick; and the barrier layer is from about 250 to 350Å thick.

21. The method of claim 1, wherein the patterned dielectric layer is about 11,100Å thick; and the barrier layer is about 300Å thick.

22. The method of claim 1, wherein the partially removed overlying metal layer has a thickness of from about 6000 to 8000Å.

23. The method of claim 1, wherein the partially removed overlying metal layer has a thickness of about 7000Å.

24. A method of polishing a metal layer, comprising the steps of:

providing a structure having an upper patterned dielectric layer; the patterned dielectric layer having an opening formed therein;

forming a barrier layer over the patterned upper dielectric layer, the barrier layer lining the opening;

forming a metal layer over the barrier layer, filling the opening;

conducting a first polish step on a first platen employing a first slurry composition, the first polish step removing a portion of the overlying metal layer;

conducting a second polish step on a second platen employing the first slurry composition, the second polish step polishing the partially removed overlying metal layer and exposing portions of the barrier layer overlying the patterned upper dielectric layer;

conducting a third polish step on the second platen employing a second slurry composition, the third polish step removing the exposed barrier layer portions and exposing underlying portions of the patterned upper dielectric layer; and

conducting a fourth polish step on a third platen employing the second slurry composition and BTA, the fourth polish step buffing the exposed upper dielectric layer portions.

25. The method of claim 24, wherein the first slurry composition is 600y-73 slurry manufactured by Cabot Microelectronics comprised of:

Al_2O_3: from about 0.4 to 0.6 wt. %;

H_2O_2: from about 2.6 to 3.4 wt. %;

KOH to adjust pH value; and

BTA as a corrosion behavior inhibitor.

26. The method of claim 24, wherein the first slurry composition is 600y-73 slurry manufactured by Cabot Microelectronics comprised of:

Al_2O_3: about 0.5 wt. %;

H_2O_2: from about 2.8 to 3.2 wt. %;

KOH to adjust pH value; and

BTA as a corrosion behavior inhibitor.

27. The method of claim 24, wherein the first slurry composition is 600y-73 slurry manufactured by Cabot Microelectronics having:

a) a pH of from about 2.8 to 4.3; and

b) a particulate size of from about 115 to 155 nm, weight basis.

28. The method of claim 24, wherein the first slurry composition is 600y-73 slurry manufactured by Cabot Microelectronics having:

a) a pH of about 4.1; and

b) a particulate size of from about 120 to 150 nm, weight basis.

29. The method of claim 24, wherein the second slurry composition is SS6 slurry manufactured by Cabot Microelectronics comprised of:

SiO_2: from about 5.8 to 6.2 wt. %; and

KOH to adjust pH value.

30. The method of claim 24, wherein the second slurry composition is SS6 slurry manufactured by Cabot Microelectronics comprised of:

SiO_2: about 6.0 wt. %; and

KOH to adjust pH value.

31. The method of claim 24, wherein the second slurry composition is SS6 slurry manufactured by Cabot Microelectronics having:

a) a pH of from about 9.8 to 11.4; and

b) a particulate size of from about 125 to 185 nm, weight basis.

32. The method of claim 24, wherein the second slurry composition is SS6 slurry manufactured by Cabot Microelectronics having:

a) a pH of from about 10.0 to 11.2; and

b) a particulate size of from about 130 to 180 nm, weight basis.

33. The method of claim 24, wherein the fourth polish step employs the second slurry composition that is SS6 slurry manufactured by Cabot Microelectronics comprised of:

SiO_2: from about 5.8 to 6.2 wt. %; and

KOH to adjust pH value;

and from about 0.10 to 0.14% BTA.

34. The method of claim 24, wherein the fourth polish step employs the second slurry composition that is SS6 slurry manufactured by Cabot Microelectronics comprised of:

SiO_2: about 6.0 wt. %; and

KOH to adjust pH value;

and about 0.12% BTA.

35. The method of claim 24, wherein the fourth polish step employs the second slurry composition that is SS6 slurry manufactured by Cabot Microelectronics having:

a) a pH of from about 9.8 to 11.4; and

b) a particulate size of from about 125 to 185 nm, weight basis;

and from about 0.10 to 0.14% BTA.

36. The method of claim 24, wherein the fourth polish step employs the second slurry composition that is SS6 slurry manufactured by Cabot Microelectronics having:

a) a pH of from about 10.0 to 11.2; and

b) a particulate size of from about 130 to 180 nm, weight basis;

and about 0.12% BTA.

37. The method of claim 24, wherein:

the first polish step is conducted at from about 2.0 to 2.4 psi for from about 36 to 44 seconds; and then at from about 1.0 to 1.4 psi for from about 18 to 22 seconds;

the second polish step is conducted at from about 1.0 to 1.4 psi for from about 41 to 49 seconds;

the third polish step is conducted at from about 1.8 to 2.2 psi for from about 31 to 39 seconds; and

the fourth polish step is conducted at from about 1.8 to 2.2 psi for from about 40 to 60 seconds.

38. The method of claim 24, wherein:

the first polish step is conducted at about 2.2 psi for about 40 seconds; and then at about 1.2 psi for about 20 seconds;

the second polish step is conducted at about 1.2 psi for about 45 seconds;

the third polish step is conducted at about 2.0 psi for about 35 seconds; and

the fourth polish step is conducted at about 2.0 psi for about 50 seconds.

39. The method of claim 24, wherein the structure is a semiconductor substrate.

40. The method of claim 24, wherein the upper patterned dielectric layer is comprised of silicon oxide, silicon nitride, FSG or silicon oxynitride; the barrier layer is comprised of TaN or Ta; and the metal layer is comprised of copper, aluminum or gold.

41. The method of claim 24, wherein the upper patterned dielectric layer is comprised of silicon oxide; the barrier layer is comprised of TaN; and the metal layer 18 is comprised of copper.

42. The method of claim 24, wherein the patterned dielectric layer is from about 10,000 to 12,000Å thick; and the barrier layer is from about 250 to 350Å thick.

43. The method of claim 24, wherein the patterned dielectric layer is about 11,100Å thick; and the barrier layer is about 300Å thick.

44. The method of claim 24, wherein the partially removed overlying metal layer has a thickness of from about 6000 to 8000Å.

45. The method of claim 24, wherein the partially removed overlying metal layer has a thickness of about 7000Å.

46. A method of polishing a metal layer, comprising the steps of:

providing a structure having an upper patterned dielectric layer; the patterned dielectric layer having an opening formed therein;

forming a barrier layer over the patterned upper dielectric layer, the barrier layer lining the opening;

forming a metal layer over the barrier layer, filling the opening;

conducting a first polish step employing a first slurry composition, the first polish step removing a portion of the overlying metal layer; wherein the first slurry

composition is 600y-73 slurry manufactured by Cabot Microelectronics comprised of:

Al_2O_3: from about 0.4 to 0.6 wt. %;

H_2O_2: from about 2.6 to 3.4 wt. %;

KOH to adjust pH value; and

BTA as a corrosion behavior inhibitor

conducting a second polish step employing the first slurry composition, the second polish step polishing the partially removed overlying metal layer and exposing portions of the barrier layer overlying the patterned upper dielectric layer;

conducting a third polish step employing a second slurry composition, the third polish step removing the exposed barrier layer portions and exposing underlying portions of the patterned upper dielectric layer; wherein the second slurry composition is SS6 slurry manufactured by Cabot Microelectronics comprised of:

SiO_2: from about 5.8 to 6.2 wt. %; and

KOH to adjust pH value;

and

conducting a fourth polish step employing the second slurry composition and from about 0.10 to 0.14% BTA, the fourth polish step buffing the exposed upper dielectric layer portions.

47. The method of claim 46, wherein the first polish step is conducted on a first platen; the second and third polish steps are conducted on a second platen; and the fourth polish step is conducted on a third platen.

48. The method of claim 46, wherein the first slurry composition is comprised of:

Al_2O_3: about 0.5 wt. %;

H_2O_2: from about 2.8 to 3.2 wt. %;

KOH to adjust pH value; and

BTA as a corrosion behavior inhibitor.

49. The method of claim 46, wherein the first slurry composition has:

a) a pH of from about 2.8 to 4.3; and

b) a particulate size of from about 115 to 155 nm, weight basis.

50. The method of claim 46, wherein the first slurry composition has:

a) a pH of about 4.1; and

b) a particulate size of from about 120 to 150 nm, weight basis.

51. The method of claim 46, wherein the second slurry composition is comprised of:

SiO_2: about 6.0 wt. %; and

KOH to adjust pH value.

52. The method of claim 46, wherein the second slurry composition has:

a) a pH of from about 9.8 to 11.4; and

b) a particulate size of from about 125 to 185 nm, weight basis.

53. The method of claim 46, wherein the second slurry composition has:

a) a pH of from about 10.0 to 11.2; and

b) a particulate size of from about 130 to 180 nm, weight basis.

54. The method of claim 46, wherein the fourth polish step employs the second slurry composition comprised of:

SiO_2: about 6.0 wt. %; and

KOH to adjust pH value;

and about 0.12% BTA.

55. The method of claim 46, wherein the fourth polish step employs the second slurry composition that is SS6 slurry manufactured by Cabot Microelectronics having:

a) a pH of from about 9.8 to 11.4; and

b) a particulate size of from about 125 to 185 nm, weight basis;;

and from about 0.10 to 0.14% BTA.

56. The method of claim 46, wherein the fourth polish step employs the second slurry composition that is SS6 slurry manufactured by Cabot Microelectronics having:

a) a pH of from about 10.0 to 11.2; and

b) a particulate size of from about 130 to 180 nm, weight basis;

and about 0.12% BTA.

57. The method of claim 46, wherein:

the first polish step is conducted at from about 2.0 to 2.4 psi for from about 36 to 44 seconds; and then at from about 1.0 to 1.4 psi for from about 18 to 22 seconds;

the second polish step is conducted at from about 1.0 to 1.4 psi for from about 41 to 49 seconds;

the third polish step is conducted at from about 1.8 to 2.2 psi for from about 31 to 39 seconds; and

the fourth polish step is conducted at from about 1.8 to 2.2 psi for from about 40 to 60 seconds.

58. The method of claim 46, wherein:

the first polish step is conducted at about 2.2 psi for about 40 seconds; and then at about 1.2 psi for about 20 seconds;

the second polish step is conducted at about 1.2 psi for about 45 seconds;

the third polish step is conducted at about 2.0 psi for about 35 seconds; and

the fourth polish step is conducted at about 2.0 psi for about 50 seconds.

59. The method of claim 46, wherein the structure is a semiconductor substrate.

60. The method of claim 46, wherein the upper patterned dielectric layer is comprised of silicon oxide, silicon nitride, FSG or silicon oxynitride; the barrier layer

is comprised of TaN or Ta; and the metal layer is comprised of copper aluminum or gold.

61. The method of claim 46, wherein the upper patterned dielectric layer is comprised of silicon oxide; the barrier layer is comprised of TaN; and the metal layer 18 is comprised of copper.

62. The method of claim 46, wherein the patterned dielectric layer is from about 10,000 to 12,000Å thick; and the barrier layer is from about 250 to 350Å thick.

63. The method of claim 46, wherein the patterned dielectric layer is about 11,100Å thick; and the barrier layer is about 300Å thick.

64. The method of claim 46, wherein the partially removed overlying metal layer has a thickness of from about 6000 to 8000Å.

65. The method of claim 46, wherein the partially removed overlying metal layer has a thickness of about 7000Å.